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(54) Boiler furnace combustion system.

(57) The known boiler furnace combustion system of the type that main burners are disposed on side walls of or at corners of a square-barrel-shaped boiler furnace having a vertical axis, the burner axes are directed tangentially to an imaginary coaxial cylindrical surface, also additional air blow nozzles are disposed in the boiler furnace at a high level than the main burners, so that unburnt fuel left in a reducing atmosphere or a low oxygen concentration atmosphere of a main burner combustion region can be perfectly burnt by air blown through the additional air blow nozzles, is improved. The improvements reside in that the additional air blow nozzles are disposed as divided into at least two groups at higher and lower levels, the additional air blow nozzles at the lower level are provided at the corners of the boiler furnace with their axes directed tangentially to a second imaginary coaxial cylindrical surface having a larger diameter than the first imaginary coaxial cylindrical surface, and the additional air blow nozzles at the higher level are provided at the centers of the side wall surfaces of the boiler furnace with their axes directed tangentially to a third imaginary coaxial cylindrical surface having a smaller diameter than the second imaginary coaxial cylindrical surface.

BOILER FURNACE COMBUSTION SYSTEM

BACKGROUND OF THE INVENTION:

Field of the Invention:

The present invention relates to a boiler furnace combustion system, and more particularly to improvements in an electric utility or industrial boiler furnace combustion system.

Description of the Prior Art:

At first, one example of a boiler furnace in the prior art will be explained with reference to Figs. 5 to 7. Among these figures, Fig. 5 is a vertical cross-section view Fig. 6 is a horizontal cross-section view taken along line VI-VI in Fig. 5, and Fig. 7 is another horizontal cross-section view taken along line VII-VII in Fig. 5.

In these figures, reference numeral 01 designates a boiler furnace main body, numeral 02 designates main burner wind boxes, numeral 03 designates main burner air nozzles, numeral 04 designates main burner fuel injection nozzles, numeral 05 designates air ducts for main burners, numeral 06 designates fuel feed pipes, numeral 07 designates additional air ducts, numeral 09 designates flames, numeral 10 designates air for main burners, numeral 11 designates fuel such as pulverized coal, petroleum, gaseous fuel or the like, numeral 12 designates additional air, numeral 13 designates unburnt combustion gas, numeral 14 designates combustion exhaust gas, numeral 15 designates wind boxes for additional air, numeral 16 designates blow nozzles for additional air, and numeral 20 designates imaginary cylindrical surfaces.

At lower corner portions of a square-barrel-shaped boiler furnace main body 01 having a nearly vertical axis are respectively provided main burner wind boxes 02, and at upper corner portions of the same main body are respectively provided wind boxes 15 for additional air (hereinafter abbreviated as AA). In each main burner wind box 02 are provided main burner fuel injection nozzles 04 and main burner air nozzles 03 as directed nearly horizontally.

Fuel 11 sent from a fuel feed installation not shown is fed to the main burner fuel injection nozzles 04 through the fuel feed pipes 06 and injected into the boiler furnace 01. On the other hand, main burner air 10 is sent from a ventilating installation not shown through the main burner air ducts 05 to the main burner wind boxes 02, and it is blown into the boiler furnace 01 through the main burner air nozzles 03.

Injection of the fuel 11 and blowing of the main burner air 10 is effected in the tangential direction to a imaginary cylindrical surface 20 which is imagined at the central portion of the boiler furnace 01. The fuel 11 blown into the boiler furnace 01 along a tangential direction to the imaginary cylindrical surface 20 is ignited by an ignition source not shown to form flames, and as it diffuses and mixes with the main burner air 10 blown in the tangential direction from the main burner air nozzles 03, combustion is continued.

Here, the main burner air 10 is fed at a rate lower than a theoretical air feed rate that is necessary for combustion of the fuel 11 injected into the boiler furnace 01, and so, the inside of the boiler furnace 01 lower than the AA blowing portion, is held at a state of reducing atmosphere. Accordingly, the combustion gas produced by combustion of the fuel 11 is unburnt combustion gas 13 containing unburnt fuel at the portion lower than the AA blowing portion.

The AA 12 is fed from a ventilating installation not shown which is the same as that for the main burner air 10, or from a separately disposed ventilating installation not shown through the AA ducts 07, and it is blown into the boiler furnace 01 in a tangential manner like the main burner air 10 from the AA blow nozzles 16 disposed nearly horizontally in AA wind boxes 15. Normally, blowing of the AA 12 is effected in the same tangential direction with respect to the same imaginary cylindrical surface 20 as that imagined at the central portion of the boiler furnace 01 in the case of the blowing of the main burner air 10. The blowing flow rate of the AA 12 is set at such an air flow rate that it can sufficiently feed oxygen necessitated for perfectly burning unburnt fuel in the unburnt combustion gas 13.

The AA 12 blown into the boiler furnace 01 is mixed with the unburnt combustion gas 13 by diffusion, thus makes the unburnt fuel in the unburnt combustion gas 13 perfectly burn, and is exhausted to the outside of the boiler furnace 01 as combustion exhaust gas 14.

In such boiler furnace in the prior art, the combustion gas produced by combustion of the fuel 14 injected through the main burner fuel injection nozzles 04 becomes unburnt combustion gas 13 due to the fact that the flow rate of the main burner air 10 is less than a theoretical air flow rate, and in the region lower than the AA blowing portion is formed a reducing atmosphere. Consequently, in the region lower than the AA blowing portion, nitro-

gen oxides (hereinafter represented by NO_x) produced by combustion of the fuel 11 is reduced and decreased in amount, and instead intermediate products such as ammonia (NH_3), cianic acid (HCN) and the like are produced.

Subsequently, in the AA blowing portion, completion of combustion of the unburnt components in the unburnt combustion gas 13 is contemplated by blowing AA 12 through the AA blowing nozzles 16. But at that time since the intermediate products such as NH_3, HCN and the like are oxidized and transformed into NO_x, for the purpose of suppressing the transformation rate into NO_x the blowing of AA 12 is carried out in a relatively low-temperature (about 1000 - 1200 °C) atmosphere portion within the boiler furnace 01.

The combustion gas produced by combustion of the fuel 11 blown through the main burner fuel injection nozzles 04 becomes unburnt combustion gas 13 because the flow rate of the main burner air 10 is less than the theoretical air flow rate with respect to the fuel 11, and it rises while it is swirling. As the unburnt combustion gas 13 rises, the outer diameter of the swirl flow of the unburnt combustion gas 13 becomes gradually large, and in the proximity of the AA blowing portion, unburnt combustion gas 13 flowing along the wall of the boiler furnace 01 increases.

The blowing momentum of the AA 12 is about 1/5 to 1/3 as small as the blowing momentum of the main burner air 10, provided that the blowing velocities are equal to each other. The AA 12 blown from the AA blowing nozzles 16 at the respective corner portions into the flow of the unburnt combustion gas 13, is divided into that diffuses and mixes with the main flow portion of the unburnt combustion gas 13 and that penetrates through the main flow portion and flows towards the central portion of the boiler furnace 01. The AA 12 flowing towards the central portion of the boiler furnace 01 is attenuated in momentum due to the fact that it penetrated through the main flow portion of the unburnt combustion gas and that the distance from the AA blowing nozzle 16 to the central portion of the boiler furnace 01 is long, hence it does not diffuse nor mix with the unburnt combustion gas 13 in the proximity of the central portion of the boiler furnace 01, accordingly it rises without contributing to completion of combustion of the unburnt combustion gas, and it is exhausted from the outlet of the boiler furnace 01.

Therefore, in order to complete combustion of unburnt components in the unburnt combustion gas 13 within the boiler furnace 01 in the prior art, countermeasures such as ① increasing a total combustion air flow rate (a flow rate of main burner air 10 + a flow rate of AA 12), ② elongating a stay time of combustion gas from the AA blowing portion up to the outlet of the boiler furnace 01, ③ weakening a reducing atmosphere under the AA blowing portion by increasing a flow rate of main burner air 10, or the like was necessary. However, there were problems that the measures ① and ③ were disadvantageous in view of countermeasure against NO_x, and the measure ② was disadvantageous in view of cost.

As described above, the boiler furnace combustion system in the prior art involved problems in connection to diffusion and mixing of the AA 12 and the unburnt combustion gas 13, and there was a problem to be resolved that if one intended to decrease NO_x, an amount of unburnt fuel was increased, while if one intended to decrease unburnt fuel, decreases of NO_x was not sufficient.

SUMMARY OF THE INVENTION:

It is therefore one object of the present invention to provide an improved boiler furnace combustion system, which can decrease both an unburnt fuel component and an NO_x content in a combustion exhaust gas without necessitating a large installation cost.

According to one feature of the present invention, there is provided a boiler furnace combustion system including a plurality of main burners disposed nearly horizontally on side wall surfaces of or at corner portions of a square-barrel-shaped boiler furnace having a vertical axis with extensions of axes of the burners directed tangentially to a cylindrical surface having its axis aligned with the axis of said boiler furnace, and a plurality of blow nozzles for additional air disposed nearly horizontally in said boiler furnace at a higher level than said main burners, in which system arrangement is made such that a main burner combustion region formed by fuel injected from said main burners and air for main burners is a reducing atmosphere or an atmosphere of low oxygen concentration of 1% or less, and that fuel not burnt in said main burner combustion region can be perfectly burnt by air blown through said blow nozzles of additional air; and which system is improved in that said plurality of blow nozzles for additional air are disposed as divided into at least two groups at upper and lower levels, said blow nozzles for additional air disposed at the lower level are provided at corner portions of said boiler furnace and have the extensions of their nozzle axes directed tangentially to a second cylindrical surface having its axis aligned with the axis of said boiler furnace and having a larger diameter than that of first said cylindrical surface, and said blow nozzles for additional air disposed at the higher level are provided at the central portions of the side wall surfaces of said boiler furnace and

have the extensions of their nozzle axes directed tangentially to a third cylindrical surface having its axis aligned with the axis of said boiler furnace and having a smaller diameter than that of said second cylindrical surface.

According to the present invention, since unburnt combustion gas has its temperature lowered as it comes close to a furnace wall, by blowing additional air fed through additional air blowing nozzles on the upstream side (at the lower level) provided at corner portion of a boiler furnace in the tangential direction of a second cylindrical surface close to the wall surface and having a larger diameter, diffusion and mixing with the unburnt combustion gas in this portion is effected reliably. In addition, by blowing additional air fed through additional air blowing nozzles on the downstream side (at the higher level) provided at the central portions of the side wall surfaces of the boiler furnace in the tangential direction of a third cylindrical surface having a smaller diameter than the second cylindrical surface, that is, towards the central portion of the boiler furnace, diffusion and mixing between the unburnt combustion gas and additional air are made uniform in a reliable manner.

The above-mentioned and other objects, features and advantages of the present invention will become more apparent by reference to the following description of preferred embodiments of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS:

In the accompanying drawings:

Fig. 1 is a longitudinal cross-section view showing one preferred embodiment of the present invention;

Fig. 2 is a transverse cross-section view of the same taken along line II-II in Fig. 1;

Fig. 3 is another transverse cross-section view of the same taken along line III-III in Fig. 1;

Fig. 4 is still another transverse cross-section view of the same taken along line IV-IV in Fig. 1;

Fig. 5 is a longitudinal cross-section view showing one example of a boiler furnace in the prior art;

Fig. 6 is a transverse cross-section view of the same taken along line VI-VI in Fig. 5;

Fig. 7 is another transverse cross-section view of the same taken along line VII-VII in Fig. 5;

Fig. 8 is a diagram comparatively showing relations of an NO_x production rate and a soot/dust concentration versus an AA blowing rate with respect to the illustrated embodiment and the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENT:

One preferred embodiment of the present invention is generally shown in Figs. 1 to 4. In these figures, reference numerals 01 to 14 designate similar component parts to those in the boiler furnace in the prior art illustrated in Figs. 5 to 7 and described previously. Here, remarking with respect to reference numerals appearing newly, reference numeral 115 designates upstream side (lower level) AA wind boxes, numeral 116 designates upstream side (lower level) AA blowing nozzles, numeral 117 designates downstream side (upper level) AA wind boxes, numeral 118 designates downstream side (upper level) AA blowing nozzles, numeral 119 designates upstream side (lower level) AA (additional air), and numeral 120 designates downstream side (upper level) AA (additional air).

Fuel 11 sent from a fuel feed installation not shown through fuel feed pipes 06 and main burner air 10 sent likewise from a ventilating installation not shown through main burner air ducts 05, are respectively injected through main burner fuel injection nozzles 04 and blown through main burner air nozzles 03 into a boiler furnace 01. The injection of the fuel 11 and the blowing of the main burner air 10 are effected in a tangential direction to an imaginary cylindrical surface 20, which is imagined to have an axis aligned with the axis of the boiler furnace 01 (See Fig. 2).

The fuel 11 injected into the boiler 01 is ignited by an ignition source not shown and forms flames 09, and as it diffuses and mixes with the main burner air blown in the tangential direction through the main burner air nozzles 03, combustion continues.

Here, the main burner air 10 is fed at a flow rate less than a theoretical air flow rate that is necessary for combustion of the fuel 11 blown into the boiler furnace 01, and thereby, the inner space of the boiler furnace 01 lower than the AA blowing portion is held under a condition of a reducing atmosphere. Combustion gas produced by combustion of the fuel 11 is unburnt combustion gas 13 containing unburnt fuel due to lack of oxygen in the space lower than the AA blowing portion, and it rises while swirling.

Above the main burner wind boxes 02 of the boiler furnace main body 01 are disposed the AA blowing portion as divided into two groups at the higher and lower levels.

In the upstream side (lower level) AA blowing portion where the unburnt combustion gas 13 reaches first, the upstream side (lower level) AA wind boxes 115 are provided at the respective corner portions of the square-barrel-shaped boiler furnace main body 01, on their inside are mounted

upstream side (lower level) AA blowing nozzles 116 nearly horizontally to blow the upstream side (lower level) AA 119 into the flow of the unburnt combustion gas 13 which has come up. Blowing of the upstream side (lower level) AA 119 from the upstream side (lower level) AA blowing nozzles 116 is effected in a tangential direction to a second imaginary cylindrical surface 21 having an axis aligned with the axis of the boiler furnace 01 and having a larger diameter than the above-mentioned imaginary cylindrical surface 20 for blowing the main burner air 10 and injecting the fuel 11, and also in the same direction as the main burner air 10 and the fuel 11 (See Fig. 3).

In the downstream side (upper level) AA blowing portion the downstream side (upper level) AA wind boxes 117 are provided at the central portions of the respective side walls of the boiler furnace main body 01, on their inside are mounted the downstream side (upper level) AA blowing nozzles 118 nearly horizontally to blow the downstream side (upper level) AA 120 therefrom into the furnace 01. In the downstream side (upper level) AA blowing nozzles 118, a third imaginary cylindrical surface 22 having a smaller diameter than the above-mentioned second imaginary cylindrical surface 21 for blowing the upstream side (lower level) AA 19 with its axis aligned with the axis of the boiler furnace 01 is imagined, and blowing of the downstream side (upper level) AA 120 is effected in a tangential direction to this third imaginary cylindrical surface 22 (See Fig. 4).

The flow rate of the AA 12 is 10% to 40% of a total combustion air flow rate (a flow rate of main burner air 10 + a flow rate of AA 12), and as this air flow is further branched into the upstream side AA 119 and the downstream side AA 120, blowing momenta of the upstream side AA 119 and the downstream side AA 120 both become small as compared to that of the main burner air 10. Especially, with respect to the upstream side (lower level) AA 119 blown from the respective corner portions of the boiler furnace main body 01, since the distance from the tip end of the blowing nozzle to the central portion of the boiler furnace 01 is long as compared to the case of the downstream side (higher level) AA 120 blown from the central portions of the respective side walls (about 1.4 times as long as the latter in the case where the cross-section of the boiler furnace 01 is square), it is worried that depending upon a blowing momentum of the upstream side (lower level) AA 119, the blowing energy may be attenuated, and the AA may rise in itself towards the outlet of the boiler furnace 01 without forming a swirl flow nor without being sufficiently diffused and mixed with the unburnt combustion gas 13. Accordingly, it is important that the upstream side (lower level) AA 119 should be blown into a swirl flow of the unburnt combustion gas 13 at an as early as possible time immediately after it has been blown into the furnace, and this is one of the reasons why the diameter of the second imaginary cylindrical surface 21 for blowing the upstream side (lower level) AA 119 was made larger than the diameter of the imaginary cylindrical surface 20 for the main burner air 10.

The unburnt combustion gas rises while it is swirling, and as it rises the outer diameter of its swirl flow becomes large, so that in the proximity of the upstream side (lower level) AA blowing portion, a flow rate of the unburnt combustion gas 13 flowing along the walls of the boiler furnace 01 increases. Since the unburnt combustion gas 13 has its gas temperature lowered as it approaches to the walls of the boiler furnace 01, in order to make the contained unburnt component perfectly burn, it is necessary to quickly feed oxygen to a region close to the walls of the boiler furnace 01. The upstream side (lower level) AA 119 is necessitated to surely mix with the unburnt combustion gas 13 in order to make an unburnt component in the flow of this unburnt combustion gas 13 in the proximity of the walls of the boiler furnace 01 perfectly burn, and this is also the reason why the diameter of the second imaginary cylindrical surface 21 was chosen to be larger than that for the main burner air 10.

In this way, the unburnt combustion gas 13 diffuses and mixes with the upstream side (lower level) AA 119 in the proximity of the walls of the boiler furnace 01, and while continuing combustion, it reaches the downstream side (higher level) AA blowing portion.

Since the downstream side (higher level) AA 120 is blown through the downstream side (higher level) AA blowing nozzles 118 provided nearly at the central portions of the side walls of the boiler furnace 01, the distance from the nozzles 118 to the third imaginary cylindrical surface 22 at the central portion of the boiler furnace 01 is short, hence attenuation in a blowing momentum is little, and therefore, the downstream side (higher level) AA forms a strong swirl flow. Accordingly, it diffuses and mixes effectively with the flow of the unburnt combustion gas 13 at the central portion of the boiler furnace 01, thus it makes an unburnt component in the flow of the unburnt combustion gas 13 perfectly burn, and it is exhausted from the outlet of the boiler furnace 01 as combustion exhaust gas 14.

As described above, in the illustrated embodiment, owing to the fact that the AA blowing portion is disposed as divided into two groups at higher and lower levels, and the upstream side (lower level) AA 119 is blown from the respective corner

portions of the boiler furnace 01 to the proximity of the walls of the boiler furnace 01, while the downstream side (higher level) AA 120 is blown from the central portions of the respective side wall surfaces towards the central portion of the boiler furnace 01, the AA 12 and the unburnt combustion gas 13 can surely diffuse and mix with each other, and thereby highly efficient combustion and reduction of the amount of soot and dust can be realized. In addition, as completion of good combustion by the AA 12 can be expected, the combustion under the AA blowing portion can be effected with a lower air-to-fuel ratio than that in the prior art.

Fig. 8 is a diagram comparatively showing relations of an NO_x production rate and a soot/dust concentration versus an AA blowing rate with respect to the illustrated embodiment and the prior art. These data are results of tests conducted by the inventors of this invention in a test furnace by making use of pulverized coal as fuel, and among these data the relations between the NO_x production rate and the AA blowing rate are generally well-known characteristics. In the case where petroleum or gaseous fuel is used in place of the pulverized coal, also an almost similar tendency is observed.

In Fig. 8, the left side scale along the ordinate represents a proportion (%) of an NO_x amount at the outlet of the furnace when AA was blown at various proportions to the NO_x amount when AA was not blown, and the right side scale represents a soot/dust concentration (mg/Nm^3) in combustion exhaust gas at the outlet of the furnace. Also, the abscissa represents a ratio (%) of an AA blowing rate to a total combustion air flow rate.

As will be seen from Fig. 8, the NO_x amount at the outlet of the furnace tends to lower as the ratio of the AA blowing rate increases. However, in the boiler furnace combustion system in the prior art, as the soot/dust concentration at the outlet of the furnace reaches a soot/dust limit value (250 mg/Nm^3) at the AA blowing rate proportion of 18%, the AA blowing rate proportion could not be increased further, and so, an NO_x production rate could not be suppressed to a low value. Whereas, in the illustrated embodiment, the point where the soot/dust concentration at the outlet of the furnace reaches the soot/dust limit value is at the AA blowing rate proportion of 33%, and so, an NO_x production rate can be reduced by about 30% as compared to the combustion method in the prior art.

This is due to the fact that as a result of increase of an AA blowing rate proportion, that is, reduction of a main burner air flow rate proportion (a flow rate of main burner air 10/(a flow rate of fuel 11 x a theoretical air flow rate), a reducing atmosphere is formed in the region lower than the AA blowing portion, and so, NO_x produced by combustion of the fuel 11 is resolved and transformed into nitrogen molecules N_2 and intermediate products such as NH_3, HCN and the like. The proportion of NO_x being transformed into N_2, NH_3, HCN and the like becomes high as an air-to-fuel ratio in the region lower than the AA blowing portion becomes low (However, at a ratio lower than a certain air-to-fuel ratio, this phenomenon is reversed.). While the NH_3 and HCN produced in the region lower than the AA blowing portion are oxidized and retransformed into NO_x by the blowing of the AA 119 and 120, if a reducing reaction in the region lower than the AA blowing portion is effected efficiently and also the blowing of the AA 119 and 120 is carried out uniformly, a proportion of retransformation into NO_x becomes low, and an NO_x rate at the outlet of the boiler furnace 01 can be suppressed to a low value.

As described in detail above, in the illustrated embodiment, since highly efficient good combustion can be carried out by effective blowing of the AA 190 and 120, the AA blowing proportion can be set at a large value, and thereby a high NO_x reduction rate which could not be realized in the prior art, can be achieved.

It is to be noted that while in the above-described embodiment, blowing of AA was effected at two upper and lower levels, in the case of a large-capacity boiler in which the boiler furnace main body 01 is large, the upstream side (lower level) AA blowing nozzles 116 and the downstream side (higher level) AA blowing nozzles 118 could be paired and a plurality of pairs of such AA blowing nozzles could be disposed.

According to the present invention, owing to the fact that the AA blowing portion is provided at least two uppwer and lower levels, the upstream side (lower level) AA is blown from the respective corner portions of the boiler furnace into the unburnt combustion gas in the proximity of the furnace wall surfaces into the central portion of the furnace, diffusion and mixing between the unburnt combustion gas and the AA are effected reliably. In addition, taking into consideration the fact that the temperature of the unburnt combustion gas is lowered as the position is close to the furnace wall surfaces, the upstream side (lower level) AA is used for promotion of combustion in the proximity of the wall surface, while the downstream side (higher level) AA is used for promotion of combustion at the central portion of the furnace, thereby a high combustion efficiency is realized, and moreover, an air-to-fuel ratio in the main burner combustion zone (under the AA blowing portion) also can be maintained low. As a result, low-NO_x and low-unburnt-component combustion can be achieved.

While a principle of the present invention has been described above in connection to one pre-

ferred embodiment of the invention, it is intended that all matter contained in the above description and illustrated in the accompanying drawings shall be interpreted to be illustrative and not in a limiting sense.

Claims

1. A boiler furnace combustion system including a plurality of main burners disposed nearly horizontally on side wall surfaces of or at corner portions of a square-barrel-shaped boiler furnace having a vertical axis with extensions of axes of the burners directed tangentially to a cylindrical surface having its axis aligned with the axis of said boiler furnace, and a plurality of blow nozzles for additional air disposed nearly horizontally in said boiler furnace at a higher level than said main burners, in which system arrangement is made such that a main burner combustion region formed by fuel injected from said main burners and air for main burners is a reducing atmosphere or an atmosphere of low oxygen concentration of 1% or less, and that fuel not burnt in said main burner combustion region can be perfectly burnt by air blown through said blow nozzles for additional air; characterized in that said plurality of blow nozzles for additional air are disposed as divided into at least two groups at upper and lower levels, said blow nozzles for additional air disposed at the lower level are provided at the corner portions of said boiler furnace and have the extensions of their nozzle axes directed tangentially to a second cylindrical surface having its axis aligned with the axis of said boiler furnace and having a larger diameter than that of first said cylindrical surface, and said blow nozzles for additional air disposed at the higher level are provided at the central portions of the side wall surfaces of said boiler furnace and have the extensions of their nozzle axes directed tangentially to a third cylindrical surface having its axis aligned with the axis of said boiler furnace and having a smaller diameter than that of said second cylindrical surface.
2. A boiler furnace combustion system as claimed in Claim 1, wherein a flow rate of the additional air is chosen to be 10 to 40% with respect to a total flow rate of combustion air, that is, with respect to the sum of a main burner air flow rate and an additional air flow rate.
3. A boiler furnace combustion system as claimed in Claim 1, wherein pulverized coal, petroleum or gaseous fuel is used as the fuel.

Fig. 1

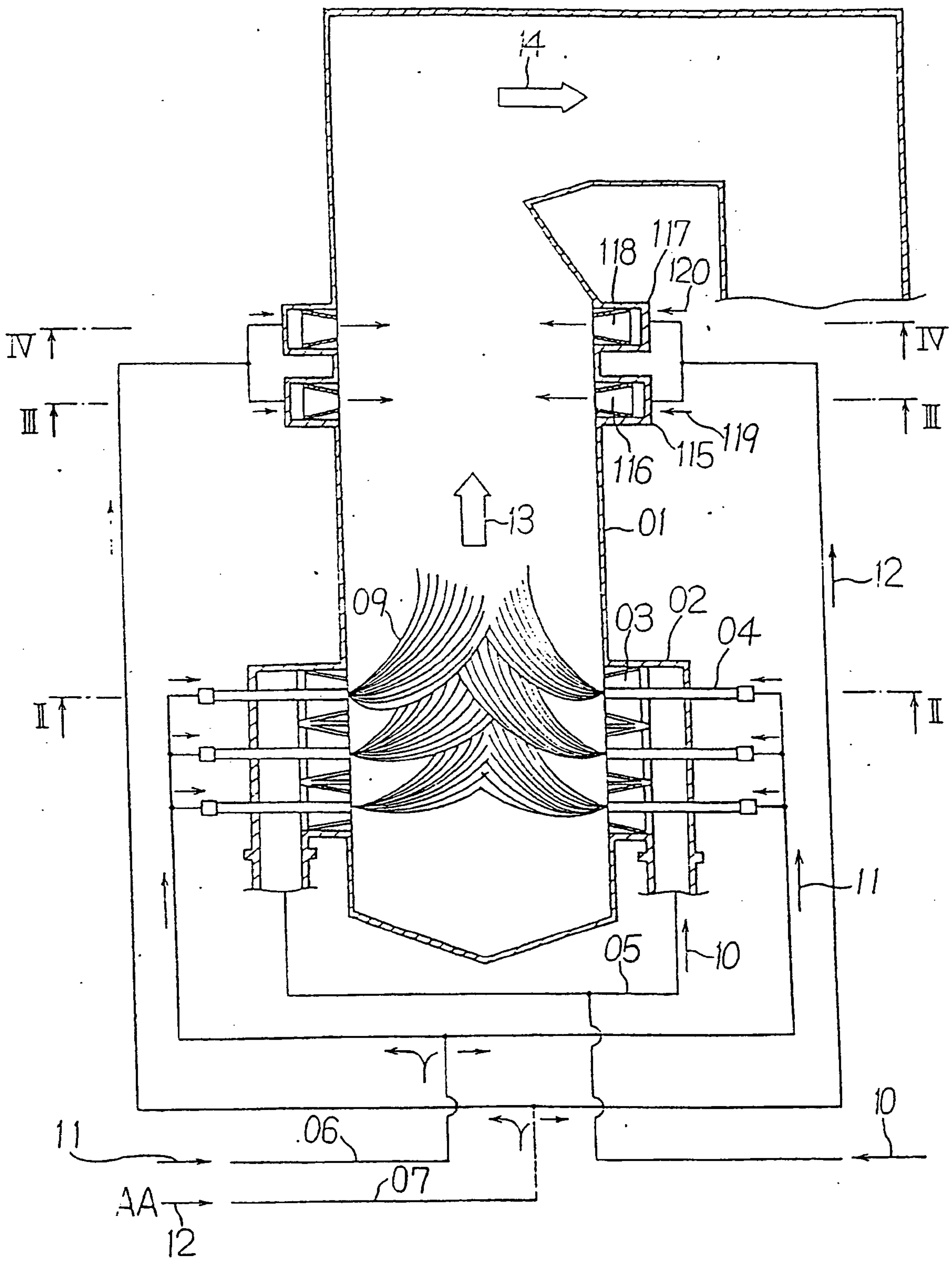

14
118
117
120
IV
III
119
115
116
13
01
12
09
03
02
04
II
11
10
05
.06
07
AA

Fig. 2

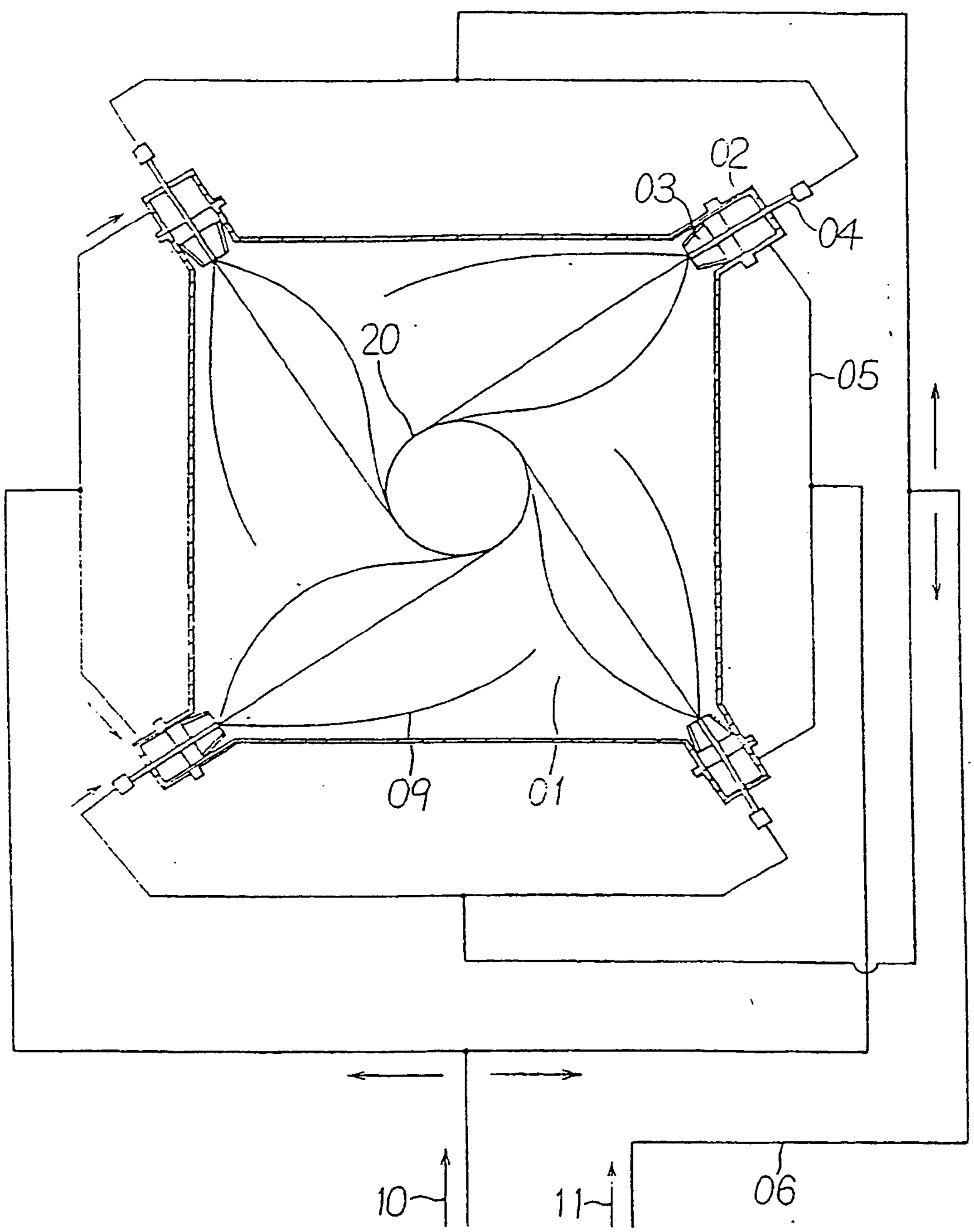


Fig. 3

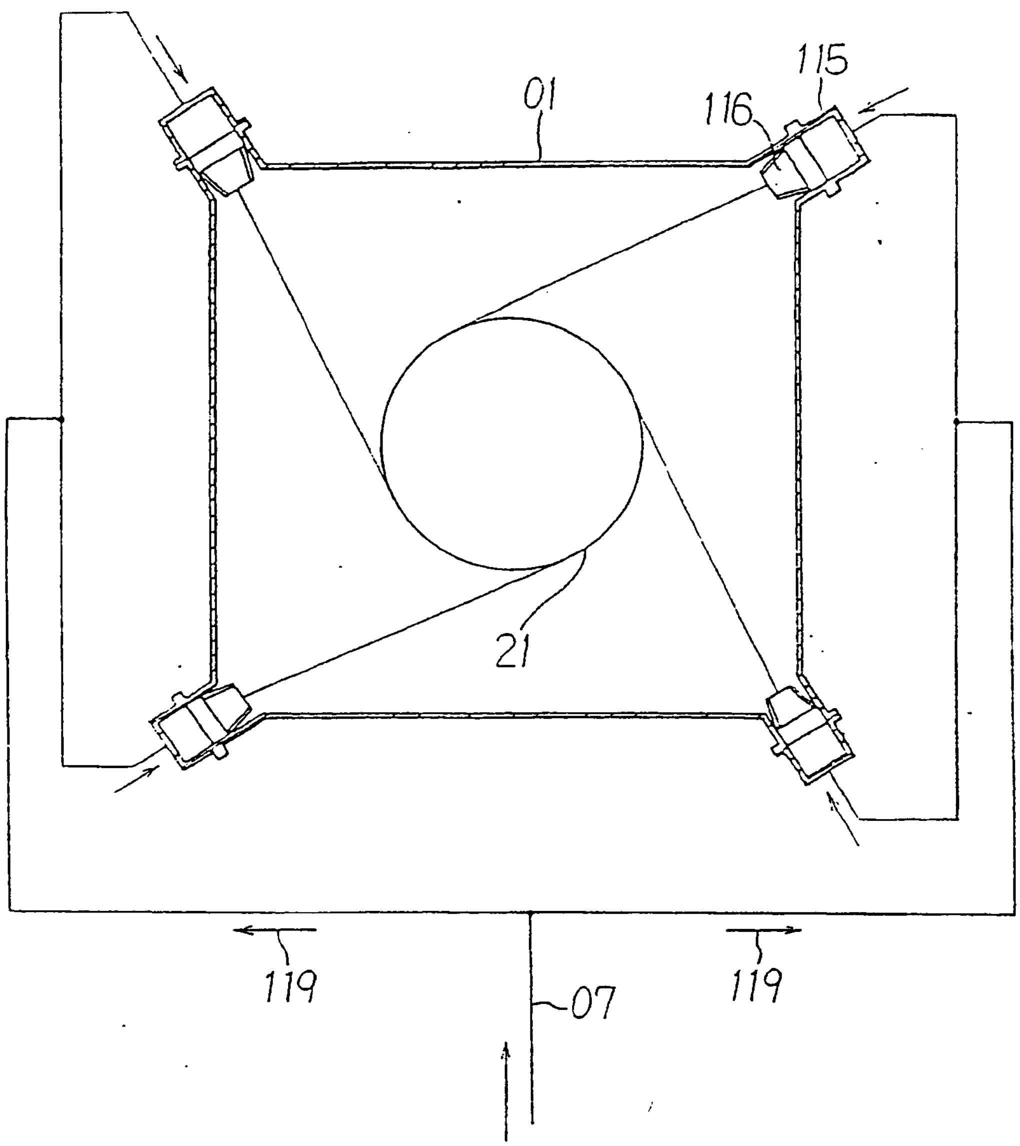


Fig. 4

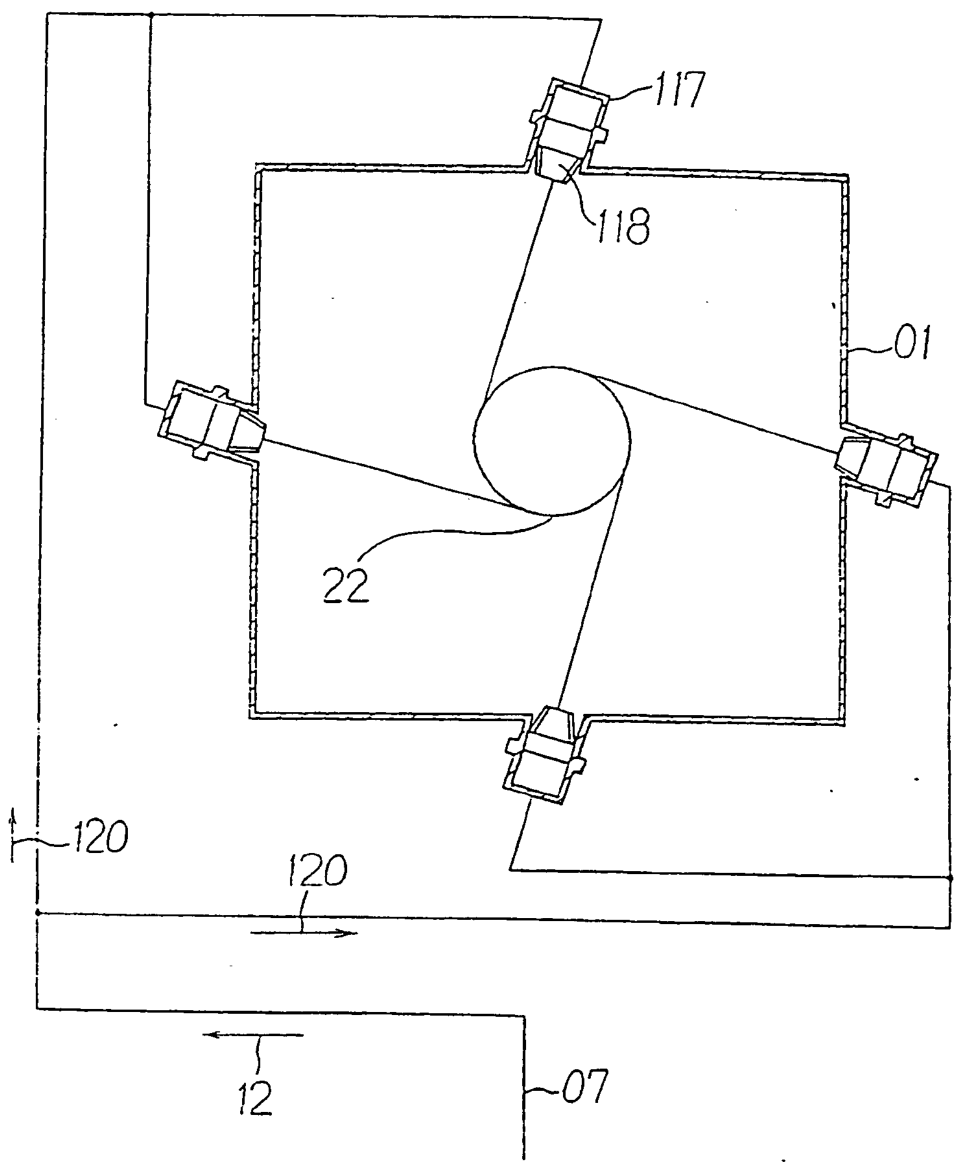


Fig. 5

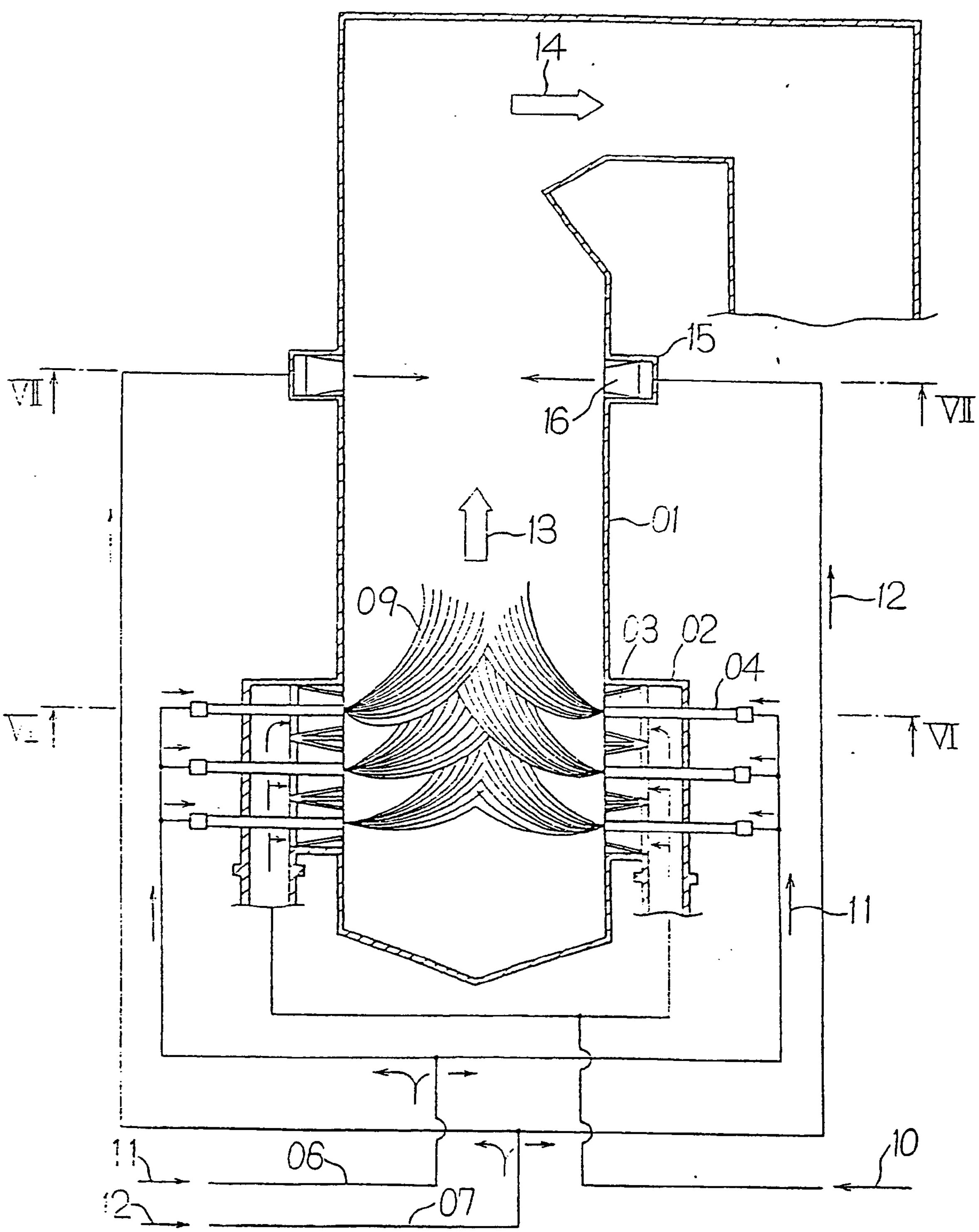


Fig. 6

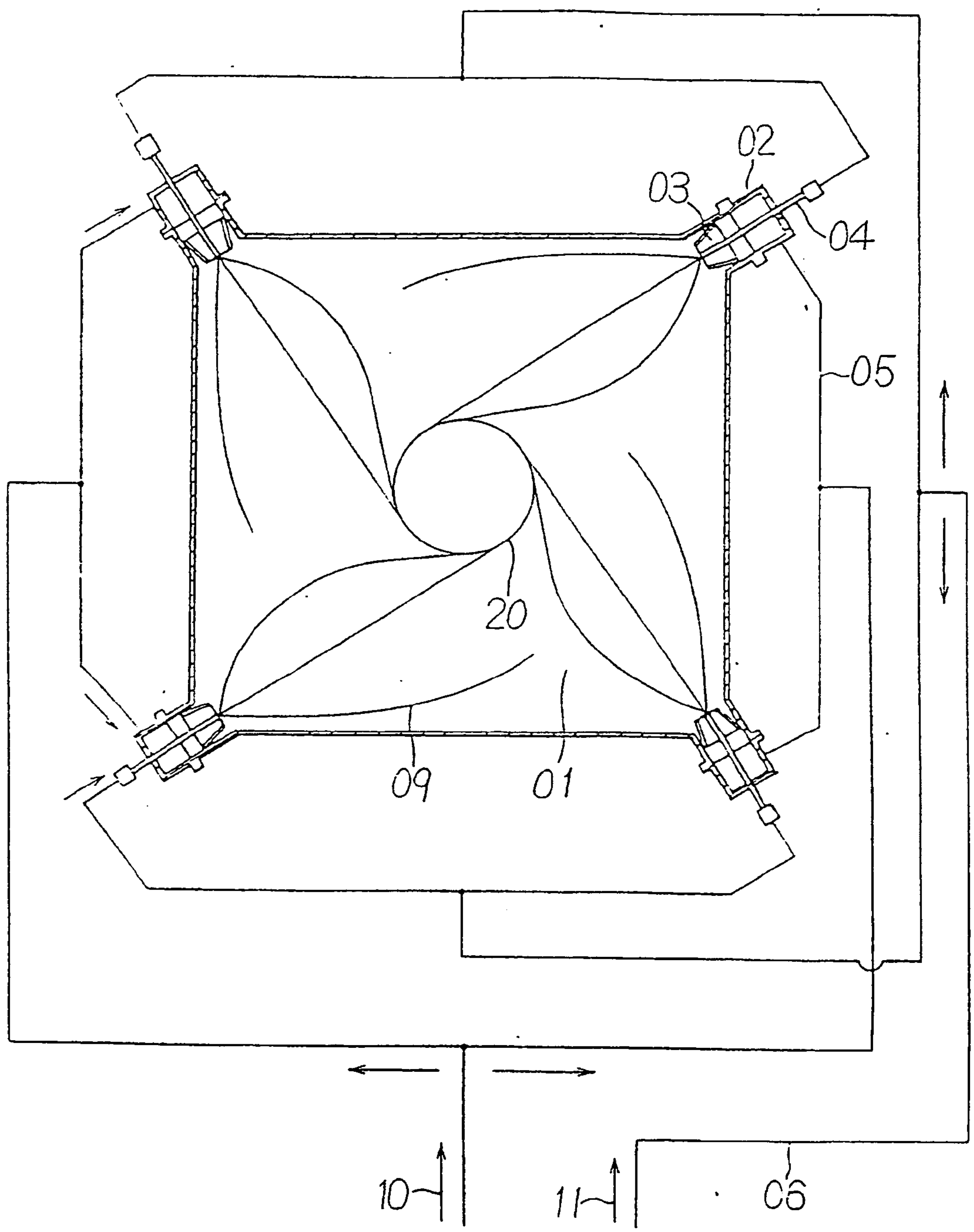


Fig. 7

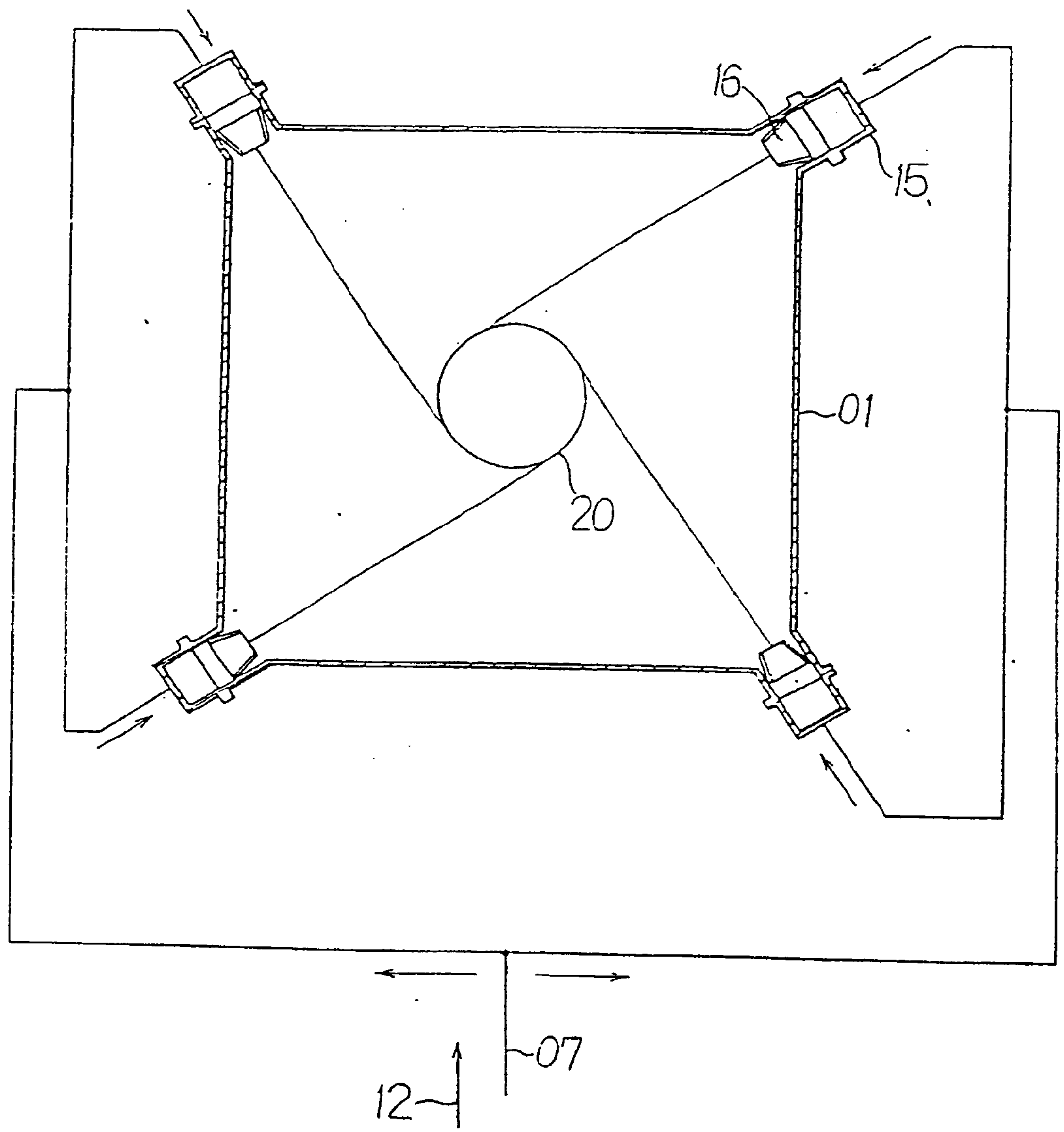
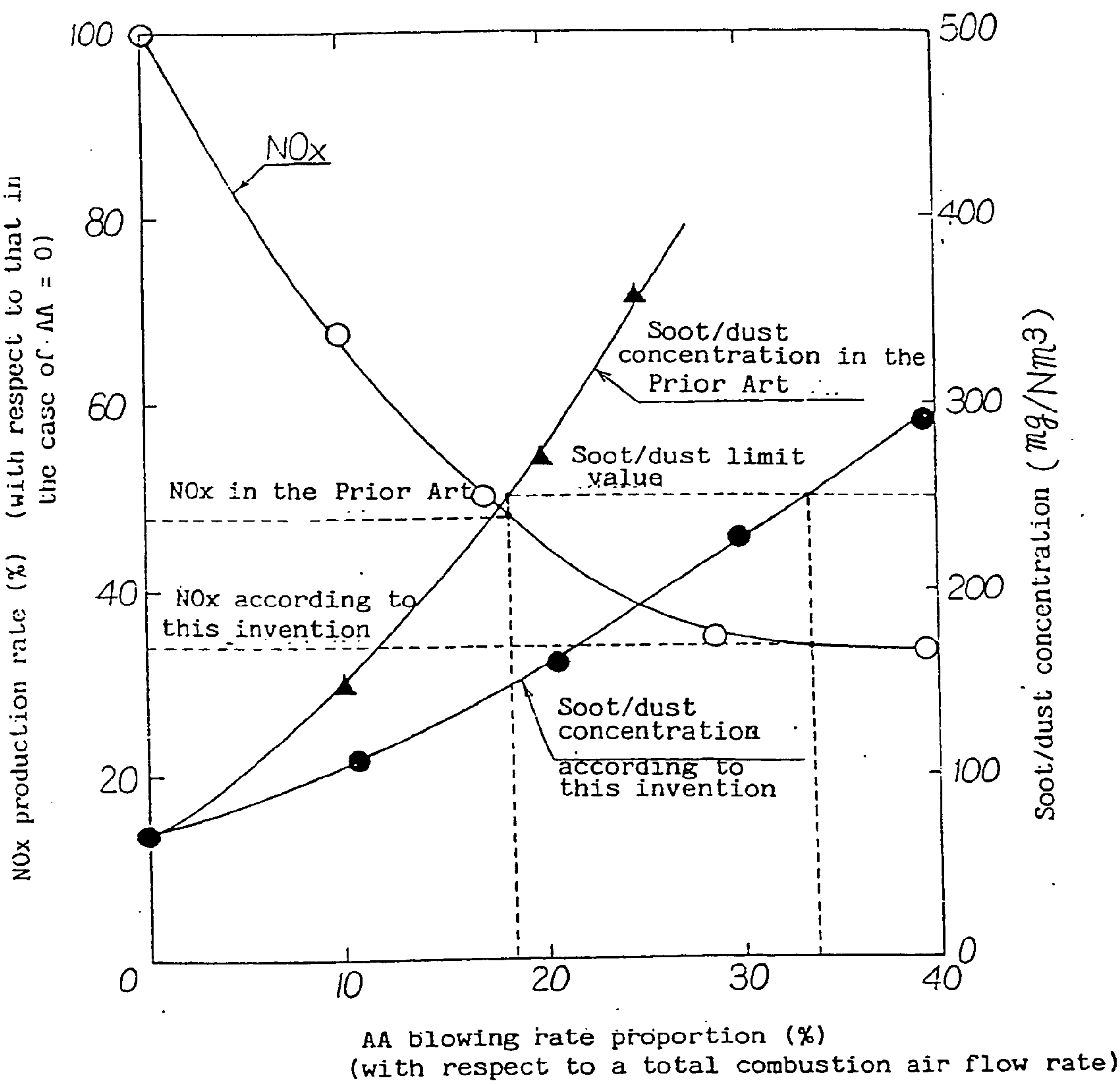


Fig. 8


NOx
Soot/dust concentration in the Prior Art
Soot/dust limit value
NOx in the Prior Art
NOx according to this invention
Soot/dust concentration according to this invention
NOx production rate (%) (with respect to that in the case of AA = 0)
Soot/dust concentration (mg/Nm3)
AA blowing rate proportion (%) (with respect to a total combustion air flow rate)
0
10
20
30
40
100
80
60
500
400
300
200
100

European
Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 11 9054

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	PATENT ABSTRACTS OF JAPAN vol. 12, no. 1 (M-656) 6 January 1988, & JP-A-62 166209 (MITSUBISHI HEAVY IND) 22 July 1987, * the whole document *	1	F 23 C 5/32 F 23 C 7/02 F 22 B 31/00
A	US-A-4 501 204 (MCCARTNEY) * the whole document *	1	
A	DE-U-8 525 256 (STEINMULLER)		
A	US-A-4 672 900 (SANTALLA)		
A	DE-A-2 837 156 (COMBUSTION ENGINEERING)		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F 23 C
F 22 B

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	28 December 90	VAN GHEEL J.U.M.

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
Y: particularly relevant if combined with another document of the same catagory
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention

E: earlier patent document, but published on, or after the filing date
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